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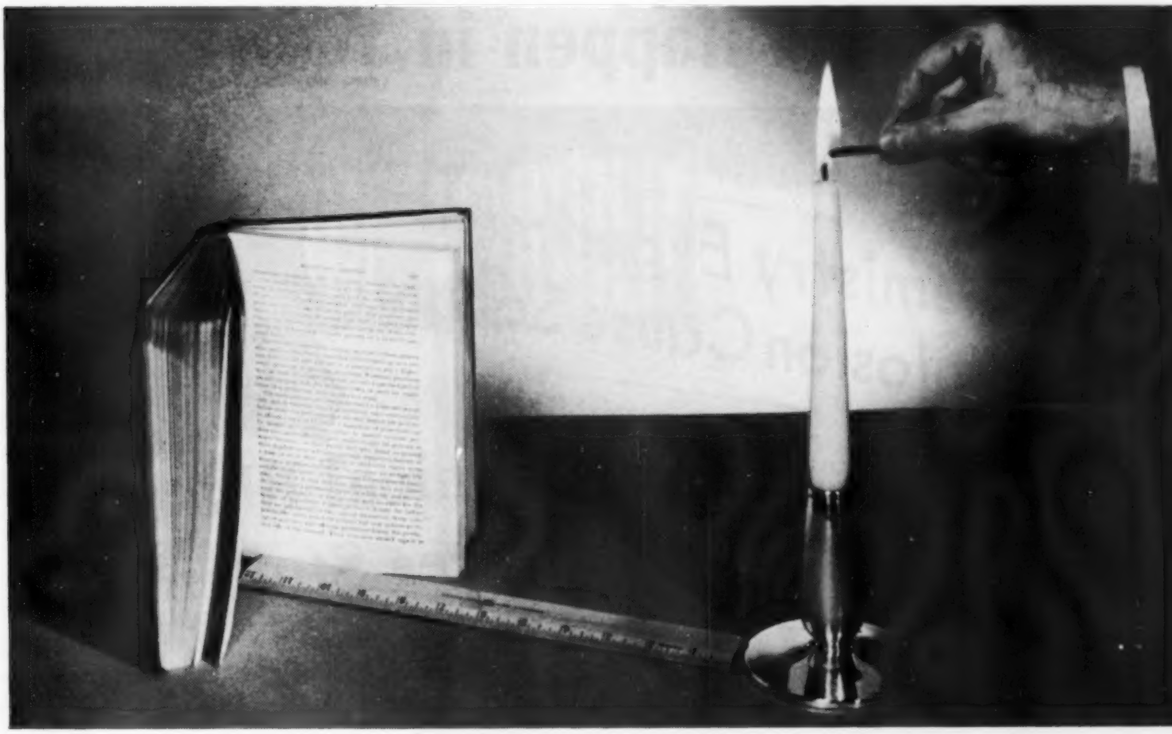
THE SCIENCE TEACHER

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION



THE SCIENCE TEACHER

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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

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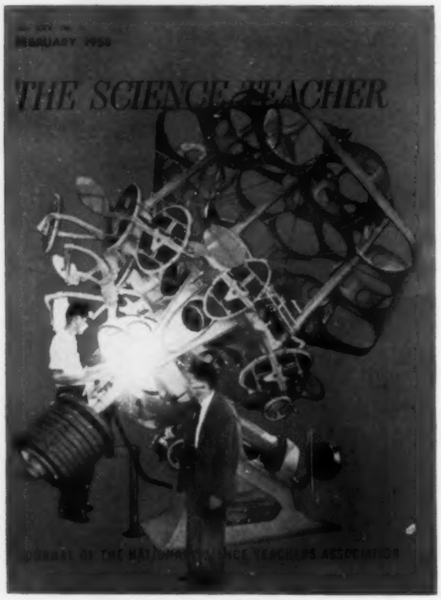
- 1958 Convention Highlights
- Summer Opportunities for Science Teachers
- The Upper Atmosphere: An IGY Report
- Teacher Demonstrations in Electricity
- Sprouting for Sprouts
- 1958 STAR Award Articles

THIS MONTH'S COVER . . .



Housed in a dome on the roof of the California Institute of Technology's Robinson Laboratory of Astrophysics, this solar furnace was built in 1932—barely 11 years after the world's first solar furnace was constructed in Jena, Germany. The Caltech solar furnace is a giant collector and concentrator of the sun's rays, which it focuses to a circle about one-half inch in diameter at a temperature of about 3000° C (5440° F)—more than half the estimated temperature of the sun's surface and higher than that reached inside of rockets.

The furnace is used to study heat-transfer problems and the behavior of materials at extremely high temperatures. It is used as a tool to melt certain highly heat-resistant materials. A refractor type, this solar furnace mounts 19 main lenses, each 24 inches in diameter and with a focal length of ten feet. Heat rays collected by the lenses, with the exception of the one in the center, are reflected by 18 flat mirrors, and then focused at the center of a 28-inch hemisphere by 19 seven-inch lenses. The entire system is mounted equatorially and automatically tracks the sun. The system weighs about five tons.

The Caltech scientist in the foreground is Dr. Pol Duwez, professor of mechanical engineering.

Readers' Column

I have just received an envelope containing another of your Packet Service series. This one, with its "The Story of Steam," "You Can Be a Civil Engineer," etc., is really fine. I have found them all very helpful. Since I teach sixth grade, much of this material is too advanced for my regular class work but how my "gifted ones" devour it! I can scarcely wait to show them "The Story of Steam."

The Bruce books ("Science Teaching Today" by Guy V. Bruce) are also of special value. I have used the first seven volumes a great deal not only for myself but in helping other teachers. I particularly like in them the described experiments and construction projects which make excellent material for displays. Teachers here have liked very much the suggested historical development ideas in the volume on light.

This year I am on leave of absence from my regular class and am a full-time student at Ohio Wesleyan University. I was asked recently to speak to the classes there on elementary science about teaching aids. I was glad to have the many things which I have received from NSTA to show these prospective teachers and I have been deluged since with requests to borrow them.

I feel I was privileged to attend the NSTA convention at Cleveland (March 1957); in those four days I received an education equal to any semester course in elementary science which I have had anywhere.

I expect that we are all going, very soon, to be subjected to even more pressure to improve our science teaching. Certainly the Association's various services are a step in the right direction.

MRS. VERRELLE REID
Ashley, Ohio

We have two science teachers in our junior high school. We shall use your attractive magazine in our classes for study and to inspire and interest the pupils to find out more about what is being and can be done in science work.

ETHEL COOPER
Plymouth, Pennsylvania, Junior High School

I am a science teacher employed by the Commonwealth of Australia, Post Master General's Department, and I wish to become a member of your Association. The NSTA publications that I have seen have impressed me greatly. They appeal immensely and their value to any teacher is most apparent.

MAXWELL THOMAS WEBBERLEY
Hobart, Tasmania

Editor's Column

We have just received a letter in our office which I would like to share with you. Here it is—complete with punctuation, spelling, etc., exactly as received.

"Dear Sir

"I just like for you to send me some book on different Subject in school so I can read. I dont like science so much but may be some other thing you can help me on when I get out of school send me some book on different Subject when I get out of high school may be you can help me four more year in other things. I am going to school at . . . High . . . La.

"May God blass You through out this 58 Year.

"From (signed)"

"Maybe you can help me. . . ."

What kind of help does this girl need? What kind of help does her teacher need, and her school? Does she really dislike science? If so, why write to NSTA for help—a book —on some other subject? What kind of facilities for teaching science do you suppose her school has—what kind of texts, reference books, simple materials for demonstrations and laboratory experiences? Has her science teacher benefited from one of the National Science Foundation Summer or Academic Year Institutes?

Who do you suppose is concerned, perhaps worried, about this girl and the situation in which she is going to high school? Granted she writes from a small rural community. Is this an excuse—or justifiable explanation? Is she perhaps a symbol of hundreds of schools, thousands of classrooms, and several hundred thousand children—able, unable, and all shades in between—in need of help today?

These were some of the questions (but not all) that ran through my mind as I read the letter. And then I thought of the various proposals and demands being made for strengthening American education—"toughen up the curriculum," "more algebra and less square dancing," "put scientists and engineers into the classrooms," "provide a categorical salary differential for science and mathematics teachers," and so forth. I wonder how many of these ideas have been tested against the *real needs* of the schools?

In case any legislators are listening, I'd like to suggest to you:

Try to find a way to give financial support to schools for: salaries to attract and hold good teachers in all subjects and at all grade levels; the purchase of textbooks, reference books, laboratory facilities for science, and the like; the provision of supervisory and consultant services for teachers; the strengthening of guidance and counseling services; curriculum study and improvement; opportunities for science teachers to keep up to date in their knowledge of subject matter and teaching techniques.

If you legislators can design legislation to meet such basic needs as these, then—

Maybe you can help.

Robert H. Carleton

Where is the SCIENCE in SCIENCE EDUCATION ? ?

By HERBERT S. ZIM

WHERE is the science in science education? This is neither a facetious nor a new question in the field of elementary and secondary education. Several important areas of the curriculum have so developed that it eventually became pertinent to ask such a question of all concerned.

In my own school days much of our class experience with music in the 7th and 8th grades was tied into what was called "music appreciation." The immediate goal was to learn to quickly recognize a piece of classical music by concentrating on a phrase, a bar, or a snatch of the melody. The height of achievement was to recognize the *Fifth Symphony* in five seconds and the *Sorcerer's Apprentice* in three. After weeks of this, it became very appropriate to ask—as it was asked in due course—"Where is the music in music education?"

In similar experiences grouped under the heading of "art appreciation," we looked at slide after slide of approved bits of painting and sculpture so that we could rattle off the name of the work and of the artist in rapid succession. This was coupled to never-ending lessons in "perspective," where we learned to draw a jar or a box placed at eye level, below eye level, above eye level, and in a dozen other unimaginative poses. Then, someone asked, "Where is the art in art education?" and during the past decade great progress has been made in giving children valid experiences from which have come better understandings and appreciations of art. A

This article is based on a speech delivered September 27, 1957 to the Illinois Elementary School Principals Association in Springfield, Illinois.

re-examination of goals is a normal educational procedure—not an impertinence.

Science is a new subject in the elementary school —so new that even its family tree is somewhat obscure. It is not the direct descendant of high school science in the same way that high school science has sprung full-blown from courses once taught in the colleges. Elementary school science still shows a strong streak inherited from the "nature study movement." In the main, this is good, because the nature study movement was, at an early date, strongly concerned with an awareness of the child as a growing person, cognizant of his interests and abilities. Perhaps unconsciously, it laid strong emphasis on the emotional side of learning, something which in recent years we have come to appreciate more and more.

If elementary school science were science-tempered and modified by the early contributions of nature study, it might well pass muster. But if we examine the family tree more closely, we see running through it a rich influx of health education. Health education is, of course, very desirable and deserving of a place in the school curriculum. But let us recognize it for what it is—health education, and not science.

We need only look a bit further to discover that the elementary and junior high school science curriculum includes a good deal of safety education, about which the same comment can be made. Another look discloses an equal or greater amount of conservation education. It, too, is essential in these times—but it is not science. It has no more logical place in the science curriculum than showing children how to properly brush their teeth or how to ride a bicycle safely to school. And we can look further and find, within science texts, laudable material on kindness to dumb animals, indoor gardening, and the like. A scientific purist might logically question whether all material on the application of technology to the home, to communication, and to transportation is really a part of science. If this viewpoint were maintained, very little would remain of our science program. The program on the secondary level is open to the same criticisms.

Unless we wish to concede that our science program should be little more than a catchall name for miscellaneous bits of fact, propaganda, opinion, and assumption, then we are certainly justified in demanding: where is science in science education?

If science cannot be defined as that which is taught in the science curriculum, a working definition is needed to implement our questions. The 18th century definition, which is still the basis for nearly all of our teaching, considers science as classified or organized knowledge. It carries the implication that nature operates according to certain universal laws, and that the slow accumulation of bit after bit of information reveals them. The tremendously important work done in classification and systemization, especially in the biological sciences, has laid the foundation for more recent advances. But these recent advances, in turn, have demanded a reconsideration of the nature of science.

Nowadays, science is not as rigidly defined, but a consensus of scientific opinion considers it a means of gaining new facts pertinent to the solution of problems. The solution of problems is not necessarily the goal of science, but the acquisition of the new facts, by which problems can be solved, most certainly is. The discovery of a new fact, whether it be the identification of a virus, the recognition of a new sub-atomic particle, or the description of a new star, can be an event of considerable magnitude. Since the discovery of new facts and their application to the solution of problems are the basis of scientific and technological progress, such a definition approaches the core of science itself.

This point of view reaffirms that the method of science is fundamentally the method of observation, and that the practice of science without firsthand observation is an impossibility. What we call "experimentation" is a valuable special technique to enhance the validity of observations. This emphasis should not be misconstrued, as was the famous dictum of Agassiz, printed on the wall of his Woods Hole laboratory—"Study nature, not books." Agassiz did not imply that science involved one and not the other. Nor does such a dichotomy exist. The study of books, from the elementary level to the professional "literature of science," is essential because the discovery of new facts clearly implies a knowledge and understanding of the old; for how else can "newness" be established? In the same way, we recognize that free and open communication is an essential part of science, even on the elementary and secondary levels.

However, the use of books and the use of facts already discovered as tools in the scientific process, often give way to such a preoccupation over these accessories that the scientific process itself is forgotten. Literally, what we call the "content" of science courses is nothing more than background material, on which science can be built. Facts are the products of science and the tools of science. To focus attention on them without reference to a specific scientific purpose, question, or problem, is something other than scientific.

Look into an average elementary classroom in an

(Continued on page 46)

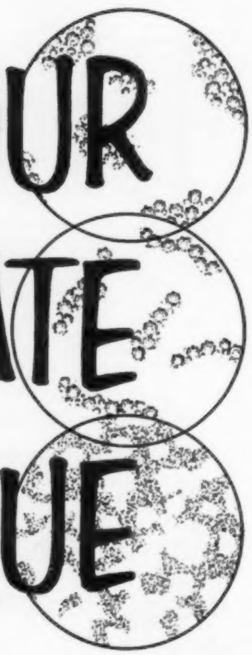
From Research to Classroom Laboratory...

A Series of Demonstrations on the Science and Engineering of Man's Environment for Healthier Living

The following articles published in THE SCIENCE TEACHER represent the results of a distinctive program of collaboration between research scientists, engineers, and technicians on the one hand, and science teachers on the other. The program is currently in operation in Cincinnati, Ohio at the Robert A. Taft Sanitary Engineering Center—the research arm of the Division of Sanitary Engineering Services of the U. S. Public Health Service, Department of Health, Education, and Welfare. Through a unique arrangement, key secondary school science teachers in Cincinnati are being exposed to the Center's unusual facilities and staff. From this exposure and informal working relationship, the teachers and scientists are designing demonstrations for use in the classroom. The purpose is to assist teachers in developing current, practical, and interesting supplementary laboratory exercises.

A Teacher-Pupil Activity for General Science Grades 7-8-9

POUR PLATE TECHNIQUE



(Growing and counting bacteria from a water sample)

By C. LEROY HEINLEIN
Cincinnati, Ohio, Public Schools

and EDWIN E. GELDREICH
Bacteriologist in Water Control Program, Robert A. Taft Sanitary Engineering Center

Background

Bacteria are among the smallest and simplest living plants. They are so small that the individual bacterium can only be seen with the aid of a powerful microscope. The largest single bacterium is approximately 1/1000 of an inch long and 1/25,000 of an inch wide. When magnified 1000 times they are often no larger than a pencil point.

Bacteria are divided into three groups: bacillus or rod-shaped, coccus or spherical-shaped, and spirillum or spiral-shaped. They are found in fresh or salt water, in soil, in the air, and in the bodies of other plants and animals. Since they lack chlorophyll with which to help make food, they must obtain their food from external sources just as animals do. Bacteria will grow only in the presence of moisture, food, and other favorable conditions. However, when they have used all of the available food supply, many of them can become inactive and remain in a resting condition for long periods of time. As soon as they again find more food and other favorable conditions, these bacteria immediately start to grow and multiply once again.

When bacteria grow and multiply into many millions of the same kind, this mass of growth becomes visible and is called a colony of bacteria. Many species of bacteria produce a colony with a distinctive shape, texture, and sometimes even a pronounced color. Therefore, some identification

is possible without the aid of a microscope. The bacteriologist usually studies the reactions of single species or kinds of bacteria. He tries to find what nutrients or food materials a particular kind of bacterium likes best; what types of sugars it will ferment, the way it is stained by various biological dyes, and many other procedures which might help identify that particular organism.

The student should read some references on bacteriology (the study of bacteria) and discuss the experiments with the biology or science teacher before doing any of the laboratory work. Even though the bacteria encountered in these experiments are probably harmless, the student should wash his hands in soap and water after completing the experiments and never put any of this material to the mouth. No food should be eaten in the laboratory. The culturing of bacteria requires adequate preparation of sterile nutrients and materials which should be done by the teacher.

Water is examined daily in many public health laboratories throughout the world to be certain it is safe to drink. The bacteriologist does not look for disease-producing bacteria directly because their discovery requires special techniques and skills. To look for the disease-producing bacteria might be compared to looking for a needle in a haystack. Instead, the bacteriologist looks for the kinds of bacteria which are always present in human waste or feces. Such a group of bacteria are called the coliform bacteria. Whenever these rod-shaped coliform bacteria are found in a water sample, it indicates that this water has been polluted with human feces.

As has already been mentioned, the study of bacteria requires the use of many different kinds of tests. One test method used to see and count living bacteria in some of the bacteriological research problems at the Taft Sanitary Engineering Center is called the pour plate technique. In this method, the bacteria are carefully mixed with a bacterial food material such as nutrient agar in a special culture or petri dish. The petri dish with the mixture of bacteria and nutrient agar is then stored for one or two days at body temperature 98° F or room temperature. During this time, each bacterium grows and multiplies into many millions of the same kind. This results in a cluster of bacteria or colony big enough to see without a microscope. A colony is generally white in appearance and about the size and shape of a pinhead when seen in the nutrient agar. All colonies are counted and the number of colonies represents the original number of individual bacteria present in the sample.

PUBLIC HEALTH SERVICE PHOTOS BY DON MORAN

Water pollution chemistry apparatus is explained by Harry G. Hanson (left), director of the Public Health Service Sanitary Engineering Center at Cincinnati, to local high school teachers working in the cooperative program. With him, left to right, are Kenneth E. Vordenberg, supervisor of science for secondary schools in the Cincinnati Public Schools system; C. Leroy Heinlein, general science teacher, Woodward High School; Raymond Hartker, biology teacher, Hughes High School; Edwin Smith, physics teacher, Withrow High School; and T. Handley Diehl, chemistry teacher, Central High School.

Statement of problem

The purpose of this experiment is to show the student how the bacteriologist can observe the density of bacteria in a sample. Water is suggested in this experiment because it is relatively easy to demonstrate the high numbers of bacteria present in river, lake, well, or spring water as contrasted to few or no bacteria that might be seen in boiling the same polluted water and then making pour plates.

Materials

A. Water sample—river, lake, well, or spring
B. Sterile supplies—a large pressure cooker—sterilize 15 minutes at 15 pounds
 Several bottles of nutrient agar
 Pipettes, 1 ml, graduated in 1/10 ml
 Sample bottles, wide mouth, for water samples
 Petri dishes
C. Bacterial colony counter—could be made as a science project (see directions)

Procedure

1. Melt a bottle of sterile nutrient agar by heating it in a pan of water. After the agar is completely melted (no visible lumps of solid agar), cool to 42-45° C, the pouring temperature. Agar hardens at about 40-42° C.
2. Place 1 ml of polluted water sample in a sterile petri dish using a sterile 1 ml pipette. Pour enough melted agar in the same petri dish to cover the

entire bottom. Mix with the 1 ml of raw water by swirling gently. Let the agar-bacteria mixture stand on the lab bench for 5-10 minutes until it hardens. Invert the dish and store it in a dark place to incubate at room temperature for 2 days, or 1 day at body temperature, 98° F.

3. Repeat the above procedure using 1/10 ml as measured using your 1 ml pipette. Repeat using 1/100 ml of polluted water sample. A 1/100 ml amount of sample is obtained by mixing 1 ml of water sample with 9 ml of sterile water previously prepared in a screw-cap test tube or small screw-cap vial or bottle; mark all samples for later identification.
4. Boil the polluted water sample for 5 minutes. Cool to room temperature and make pour plates as in 2 above. Use only 1 ml for this part of the experiment.
5. After incubation, the 1, 1/10, and 1/100 ml pour plates of the original polluted water, and the one plate of boiled water should be observed for bacterial colony growth. It is not possible to identify coliform bacteria on these plates because the medium used does not produce the distinctive sheen needed for identification. Observation and colony counts can be made, however, using a bacterial colony counter. Note the differences in counts between the polluted sample and the boiled water. Point out the advantages of boiling any unknown water before using it for drinking water. Make graphs or charts of the quantities and types of colonies found in different water sources. Check the effect of disinfectants and antiseptics on bacterial cultures. What bacterial cultures can be obtained using the same procedure with milk samples?

Notes on construction of bacterial colony counter

Build a wooden light-box to contain a 25-watt electric bulb. Make a hole the size of a petri dish in the slant side of the box. Place a glass plate over this opening and rule vertical and horizontal lines on this plate about one-half of an inch apart with India ink. These lines become guide lines for counting all the colonies in the petri dish in a systematic way. This avoids counting the same colony twice while scanning the plate from left to right and from top to bottom. A support of wood must be placed on one end of the box to hold a large hand lens or reading glass (about 4X power). This makes it easier to see the small-sized colonies. (See Figure 1.)

Figure 1. Bacterial Colony Counter

A. Light source—25-watt bulb
B. Lens—4½"
C. Opening covered by lined glass—size of petri dish
D. Wooden block—rest to hold petri dish

Peering into the colony counter at the Cincinnati Center are the authors, C. Leroy Heinlein, seated, and Edwin E. Geldreich.

Application of the pour plate technique

This is a basic bacteriological method used daily in many different problems in microbiological laboratories in industry, hospitals, and public health. Examples where this method might be used are:

1. to study the effectiveness of new bacteria killing agents—antiseptics, cough drops, antibiotics;
2. to check on food utensils in public eating places;
3. to check for bacterial blood infections;
4. in the control of food spoilage;
5. in the determination of bacterial content of milk.

Streak plate technique

This bacteriological procedure is another of the methods most often used to separate different kinds of bacteria from a mixture. This technique does not provide the bacteriologist with a count of the bacteria present in the sample; it is only used to isolate and differentiate between colonies. The bacterial count can be made later using the pour plate method. This is an adaptation of a method initiated by Robert Koch in the 19th century. Streak plates are made by first pouring the sterilized

agar into a petri dish and allowing it to harden. In this experiment the streaking plates are made using EMB agar (eosin methylene blue agar).

Procedure

a. Bacterial suspension. Prepare by mixing several surface colonies from the pour plates used in the preceding experiment in 9 ml of sterile distilled water contained in a screw-cap tube. Use a nichrome wire needle or loop to put the bacterial colony in the water.

b. Cap the tube and shake to get a uniform mixture of the bacteria.

c. Use a nichrome wire needle, sterilized by heating in a flame until it is "red hot." Then it is cooled a moment, dipped about 1 mm deep into the bacterial sample and spread lightly across a prepared streak plate of EMB agar as shown in Figure 2, proceeding from A to D.

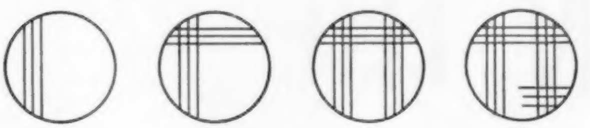


Figure 2. Streaking Sequence

d. Bring the needle in contact with the agar surface in a manner that will avoid scratching or tearing the agar. As the needle is streaked across the plate, the bacteria are separated and spread out with each streak. Fewer colonies of bacteria appear on the last streaks made than appear on the first streaks. (See Figure 3.) This enables the bacteriologist to obtain isolated colonies for study.

e. Invert the plate and incubate at 35° C for about 24 hours (use incubator).

f. Observation of the plate: examine the colonies on the plate (a magnifying lens is not necessary) noting those that have a greenish metallic sheen or lustre (E. coli) and those that are fish-eyed—gelatinous (A. aerogenes); E. coli and A. aerogenes represent two of the more common members of the coliform bacteria. These colonies indicate pollution of the water sample. All other types of colonies present on the plate are not important in this test for pollution, but they represent the bacteria normally living in water.

g. Follow up the experiment by:
   1. sketching or drawing the E. coli or A. aerogenes colonies that develop on the plates;
   2. recording the numbers and descriptions of colonies that appear on the plates but are not necessary for testing pollution;
   3. testing other samples of water or other liquids using the streak technique;
   4. examining specimens of the colonies with the lens of the colony counter.

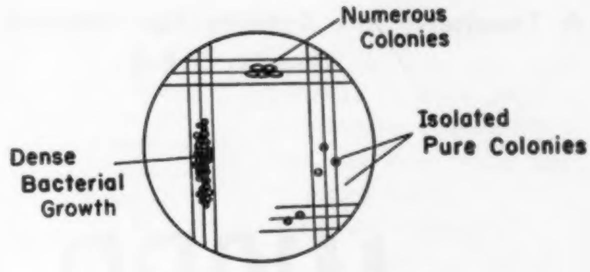


Figure 3. Streak Plate Isolation

Application of streak plate technique

This method can be used to:

a. Isolate bacteria

b. Maintain a pure culture.

c. Identify partially, or tentatively, a species by colony characteristics.

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Teacher

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A Teacher-Pupil Activity for General Science
Grades 7-8-9

MICRO-FUNGI IN THE SOIL

(Recommended for the ninth-grade student interested in mycology or in science project work)

By C. LEROY HEINLEIN
Cincinnati, Ohio, Public Schools

and WILLIAM BRIDGE COOKE
Mycologist, In-Charge, Fungus Studies, Robert A. Taft Sanitary Engineering Center

Background

The soil is a vast reservoir of chemicals which can be used by wild and cultivated plants as sources of nutrients for growth. As parts of plants or animals are returned to the soil in the form of litter, they are quickly or gradually decayed and their component parts returned to the soil as renewed material for the chemical warehouse. Agents of the decay process are many and varied. They include representatives of the protozoa, fungi, worms, insect larvae, crustaceans, and some plant roots.

Different species of these organisms have different food requirements so they attack different types of materials. Within a fragment of a leaf or twig are many different types of chemicals. One kind of mold will attack the simple sugars, another the more complex sugars and sugar-like compounds, another the cellulose, another the cutin and other substances on the surface of the leaf; still others will attack the more complicated compounds of which the skeleton of the leaf is composed. From the point of view of the fruit-bearing or spore-producing structure, two principal types of soil fungi are known—the micro-fungi or molds and the macro-fungi or mushrooms. It is with the former that this activity is concerned.

Fungi, in general, are classified as *Thallophyte*

organisms. They are simple organisms without leaves, stems, or roots. These organisms may be one-celled or consist of groups of cells. The fruits of some fungi are microscopic; others are easily seen with the unaided eye. The fungi are non-green spore-producing saprobic or parasitic thallophytes numbering some 90,000 species including slime molds, blights, mildews, bread molds, lichens, yeasts, smuts, rusts, and various other fungi which are of extreme importance to man. Some are harmful, others are essential to human life. Fungi are all alike in that they depend on previously-formed organic matter for food, either directly or indirectly. They are constantly being investigated by research laboratories, like the Taft Sanitary Engineering Center, where extensive research is carried on to determine microbiological activity in man's environment.

Looking for fungi requires very little research. The air always contains fungus spores which will grow if they find any sources of food and moisture. Some fungi prefer the moist leaf mold of the woods and grow in profusion on the ground.

The fungi are worthy of study. They are easy to study because many are visible to the unaided eye and others can be seen with the low power of a microscope. Many can be grown in culture dishes throughout the year. They are safer to study than bacteria for only a few cause human disease and it is not likely that these will be picked up in an experiment of this type.

Problem

To determine the numbers and kinds of fungi in soils.

Materials

I. Samples of soil

Types of samples of soil are listed in the order of their appearance in a soil profile—soils in layers A, B, C, D, and E are all available in wooded areas; soils D and E are available from fields and gardens.

(A) litter layer .... (composed of leaves and other plant materials which have fallen during the last year or more and are still recognizable)

(B) fermentation layer .... (composed of leaves and other plant materials which are decomposed so that they are hardly recognizable)

(C) humus layer .... (composed of leaves and other plant materials which have decomposed so they are no longer recognizable)

(D) mineral soil at surface

(E) mineral soil three inches below the surface

II. Apparatus and equipment

test tubes	L-shaped nichrome wire needle
petri dishes	pipettes (1 ml and 10 ml)
distilled water	agar (prepared dehydrated)
hot water bath (if available)	1. Cooke Rose Bengal agar
microscope	2. potato dextrose agar
cover slips #1	Amann mounting medium
graduate (25 ml)	autoclave or pressure cooker
flasks	Bunsen burner
spatula	torsion balance or dietetic scale
glass slides	6-oz or 100-ml dilution bottles

Procedure

Part I

Getting started:

1. Collect small samples of soil from all levels of the profile if they are available (collect and store in plastic containers; a school can purchase quantity amounts from drug supply houses); containers should be labelled to indicate soil layer, location, and date; information can also be entered on a card or in a notebook after the container has been numbered. If collecting is done on a field trip, the teacher should arrange for it with the owner or park superintendent beforehand.
2. From each sample collected, select three 15-ml portions of natural soil (to measure: use a 25-ml graduate, moderately packed to 15 ml); mark the samples for later identification.
3. Mix one of the 15-ml samples with 150 ml of distilled water.
4. Air-dry the remaining two 15-ml portions, being careful to keep them separate. Weigh each of these dried portions on a torsion balance, or its equivalent, and record the weight in grams to the nearest hundredth; mark the samples for later identification. The purpose of the dry sample is for translating the colonies per ml into colonies per gram following counting.

Preparing the sample in water:

5. Shake the 15-ml sample in 150 ml of water or mix in a blender or milk-shake mixer. If a blender or milk shaker is used, one minute of blending is sufficient; if done by hand, 5 minutes of shaking will suffice. Remove 5 ml of the blended soil and add to 45 ml of water or 1-part soil to 100-parts water. Shake mixture for a few seconds.
6. Repeat the mixing two more times, diluting the mixture by adding 5 ml of the first mixture of soil to 45 ml of distilled water, thus reducing the mixture to 1-part soil to 1000-parts water and finally adding 5 ml of the second mixing to 45 ml of distilled water, reducing the mixture to 1-part soil to 10,000-parts water. Mark each dilution for later identification.

7. The number of dilutions will depend on the sample; upper mineral soils, humus, and fermentation soils require more dilution. Proper dilution is determined by the trial and error method; however, when the colonies average 40-60 per plate the dilution is as near right as possible. Use the last dilution in the series of dilutions as your soil sample for testing. All samples will not require three dilutions, some samples will require more.

Preparing the agar:

8. Use dehydrated agar without antibiotics (Cooke Rose Bengal agar); this agar will eliminate some bacterial colonies but not all unless antibiotics are used.
9. Suspend proper amounts of the agar (see manual accompanying the agar; agars differ for companies which prepare them); 33 grams to a liter of water should be satisfactory.
10. Dissolve the agar in an Erlenmeyer flask of distilled water; heating may be required in a water bath (a pan of warm water large enough to hold the container of agar) depending on the rate of dissolving.
11. Place the dissolved agar in 6-oz or 100-ml dilution bottles, about ⅔ full, and autoclave for 15 minutes at 15 pounds of pressure. (Use a pressure cooker if an autoclave is not available.)

Preparing the culture:

12. Shake up the soil dilution suspension (prepared in steps 5 and 6).
13. Put one ml of soil suspension in a petri dish and pour in 15 ml of Cooke Rose Bengal agar before the agar has a chance to harden and when it is cool enough to handle safely. If the agar is too hot, it will kill the organisms present in the soil sample. (Prepare five such plates for each type of soil sample to assure accurate count.) Mark each plate for later identification.
14. Swirl petri dish gently on table top.
15. Cover the petri dish to (1) prevent contamination of the culture and (2) prevent spores from escaping into the room. Incubate right side up at room temperature for 5-7 days.
16. Repeat steps 12-15 for each type of soil and sample selected.
17. Observe and count the different colonies that develop. Do not uncover the plates. Autoclave the plates to kill the spores before washing.

Part II

Preparing cultures for study:

18. Prepare, suspend, autoclave, and pour plates of potato dextrose agar following the directions given for Cooke Rose Bengal agar.
19. Using an L-shaped nichrome wire needle, carefully pick out a very small portion from one colony growing on the Cooke Rose Bengal agar plates; place this portion on the center of the petri dish containing the prepared potato dextrose agar.
20. Cover and allow to grow at room temperature until good colonies develop. After step 24 autoclave to sterilize and discard.

Identifying colonies by making permanent mounts from slide cultures:

21. Prepare a petri dish with 10-15 ml of potato dextrose agar; allow the agar to harden; divide it into 1-cm squares with a flame-sterilized scalpel (to flame sterilize a scalpel, dip it in 95% ethyl alcohol and burn off the alcohol).
22. Prepare petri dish as in Figure 1 with one or two slides on bent tubing support. Place sufficient glycerine or water in the dish to prevent drying out. In a second dry petri dish place a quantity of cover slips; autoclave both slides and cover slips.
23. Using a flame-sterilized spatula, place one block of the agar on the center of each slide in a petri dish.
24. Touch the nichrome wire needle to a colony obtained in steps 19 and 20 and wipe it around the edge of the agar of the slide.

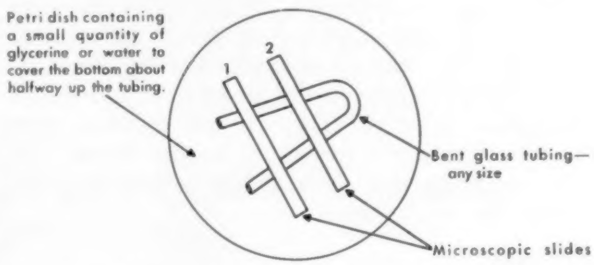

Figure 1. Arrangement of Petri Dish for Autoclaving.

25. Place a sterile cover slip on the agar with a flame-sterilized forceps; mark for later identification; incubate at room temperature for 3-4 days; after 3 days cultures can be observed directly with a microscope by focusing through the cover slip.
26. Place a glass slide on the laboratory bench; place a drop of Amann's mounting medium in the center of the slide; remove the cover slip from the incubated slide as prepared in step 25 with a sterile forceps; place the cover glass with growth on the Amann's mounting medium on the slide; if culture is successful, ring the cover glass with clear nail polish to seal and mark for later identification.
27. Carefully remove the agar from the original slide obtained in step 25 and place a drop of Amann's medium on the slide where the agar had been and cover with a cover glass; seal edges. If the culture from the first slide is not successful, repeat steps 26 and 27 using the second incubated slide.

SCIENCE–SOCIAL STUDIES WORKSHOP

THIS is the first announcement of a special workshop for teachers of science and social studies in grades 9-12 to be held next summer under the auspices of the National Science Teachers Association, the Joint Council for Economic Education, and the National Council for the Social Studies. Although details are still to be finalized, the workshop is planned for the period August 4-22 at an eastern college. Sixty teachers, one each in science and social studies, from 30 schools will be selected to participate. Sufficient funds have been assured to cover all expenses of the workshop; additional support is being sought to cover travel expenses of the participants and, it is hoped, to provide modest stipends or fellowships.

Briefly, a prime purpose will be to produce tentative plans and materials for the enhanced teaching of interrelationships of advances in science and technology and their socio-economic impact. Presentations of facts, ideas, and suggestions for teaching will be given by experts in the fields involved and by the workshop staff. The teacher participants will then develop teaching materials for tryout use and refinement during 1958-59 and possibly subsequent publication.

If you are concerned and deeply interested in this kind of curriculum effort, that is the first criterion for requesting consideration. Additional, minimal requirements include:

1. A "teammate" social studies teacher from your school.
2. A significant overlap in the students both of you would be teaching next year, or other indication of opportunities to work together in the teaching of certain courses or units in science and social studies.
3. Assurance of administrative approval and support for such experimental endeavor in curriculum and instruction within your school or school system.

Teachers who are interested should write as promptly as possible, touching on the above points and others deemed important. Write to the NSTA headquarters office: 1201 Sixteenth Street, N.W., Washington 6, D. C. Replies and additional information will be sent to correspondents as soon as available.

28. The colonies can be examined with a microscope and many identified as to genus by referring to H. L. Barnett's *Illustrated Genera of Imperfect Fungi,* Burgess Publishing Co., Minneapolis, Minn., 1955.

Follow-up

Several things may be done as follow-up including:

a) Counting the colonies to determine the number per ml of wet sample or per gram of air-dried sample.

1. Procedure:

a. Formula 1—To determine the number of colonies per ml of original wet sample

$$\frac{\text{total number of colonies for 5 plates of one sample}}{\text{number of plates}} \times \frac{\text{dilution}}{\text{15 ml}}$$

b. Formula 2—To determine the number of colonies per gram of original air-dried sample

$$\frac{\text{Number of colonies per ml x 15 ml of the wet sample}}{\text{weight of the dry sample in g}}$$

(the average weight of two 15-ml dry samples will approximate the weight of the soil in the original 15 ml of the wet sample)

2. Example:

Formula 1:

Assume that there were 5 grams of soil per 15 ml, that 40 colonies were found on each of the five plates, and that the dilution was 1 part to 10,000. There was a total, therefore, of 200 colonies or an average of 40; multiplying 40 $\times$ 10,000 indicates a total of 400,000 colonies per 15 ml or 26666 + colonies per ml $\left(\frac{400{,}000}{15}\right)$; colonies can be reported to two significant digits or 27,000 colonies.

Formula 2:

If there were 5 grams of soil per 15 ml of wet sample, then 5 grams divided into 400,000 colonies gives 80,000 colonies per gram.

b) Make charts, graphs, and drawings of the fungi found.

c) Make a collection of permanent mounts for use in the classroom, or as a project for a science fair.

d) Exchange soil samples with pupils in different parts of the United States; develop colonies and permanent mounts.

e) Make drawings of the fungi identified with the microscope; obtain additional information about these fungi; use the information and sketches in making oral or written reports.

f) Examine soils from different parts of a locality; are similar fungi found at the same depths?

g) Diagram the soil profile where soil samples were collected; identify the soils and rocks shown; mount sketches of the fungi obtained and relate these sketches to the horizon on the diagram from which they were obtained.

h) Make a soil survey of the area where you live; chart, graph, or map your findings.

i) Collect, label, and display samples of soils available in the locality where you live.

j) Experiment with the effect of sterile soils on plant growth.

k) Make a complete study of a particular mold found in soil.

Applications

a) The Taft Sanitary Engineering Center has utilized the research with micro-fungi to:

1. Develop information concerning a reservoir of antibiotic-producing organisms, information about plant and animal disease fungi, and information about deterioration fungi.
2. Trace organisms in sewage from soil reservoirs.
3. Trace spores in the air; this is important in the study of allergies.
4. Trace sources of organisms important in deterioration of any kind of material (food, cloth, bedding, etc.).

b) Research with micro-fungi is important to agricultural sciences.

1. Determine that the numbers and types of fungi present in soil are a partial index of the microbiological activity in a soil and thus of some aspects of its potential fertility.
2. Develop information about animal and plant disease fungi.
3. Trace spores in the air as agents of plant disease.

c) Research with micro-fungi is important to military science.

1. Spores in the air.
2. Deterioration of material.

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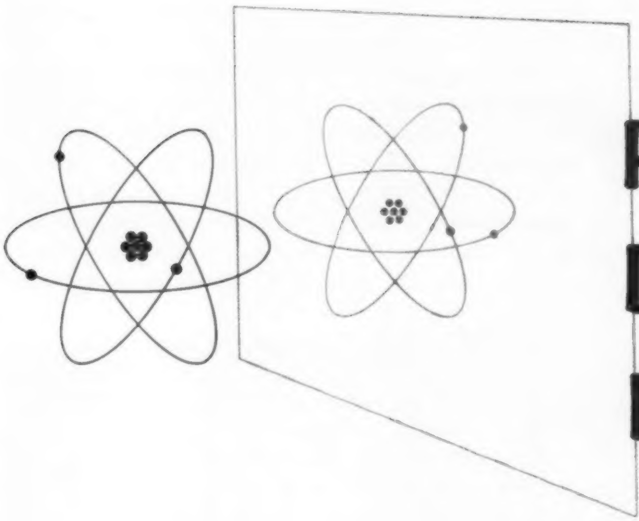
CONVENTION SPOTLIGHT

A special brochure giving up-to-the-minute details of NSTA's Sixth National Convention (Denver, March 26-29, 1958) has been mailed to all Association members. Additions are still being made, of course. The March issue of *TST* will report convention highlights as well as important additions and changes.

In the meantime, here's one addition of special interest to high school chemistry teachers. A session has been scheduled for 10 a.m. to 12 noon on Wednesday, March 26 on the American Chemical Society-NSTA high school chemistry test (see the article on page 32 of this issue). The session will be devoted to work on construction of the test. All interested teachers of high school chemistry are cordially invited—even urged—to take part.



RECENT DEVELOPMENTS IN PHYSICS

By JOHN S. TOLL

Head of the Physics Department, University of Maryland, College Park

This article is based on a lecture presented on June 29, 1957 at the 1957 Summer Conference on the Improvement of Science Teaching at the University of Maryland, co-sponsored by the University, the West Virginia Pulp and Paper Company, and the Future Scientists of America Foundation of the National Science Teachers Association.

THE BEST PRESENT ASTROPHYSICAL EVIDENCE indicates that the universe is about six billion years old. On this time scale, "recent"—as we talk of it in terms of recent developments in physics—might include the last 4000 years, in which nearly all scientific discoveries have been made. However, in order to place some limits, I will discuss only a few of the major developments in physics in the past year or two and will even then have to omit many interesting discoveries.

Undoubtedly the most important discovery during the past year has been the detection of the "non-conservation of parity." How did this discovery come about and what is its significance? Some commodity brokers showed panic when physicists first reported that "we must abandon parity." Let farmers be assured, the "parity" of physics has no connection with price supports!

One of the guiding principles in physics research has been the assumption that the laws of physics should be expressible in a form which is the same for all frames of reference, or at least for a large class of reference frames. Thus the special theory of relativity states that the laws of physics should be the same to observers moving with constant relative velocity. Similarly, it has been tacitly assumed by physicists that the laws of physics should be the same whether observed directly or through a mirror, that is, that the laws of physics are invariant under reflection. "Parity" is just the name given to the reflection character of physical entities.

This concept has been particularly useful in the study of elementary particles where it was assumed that, for each physical configuration, the mirror image of that configuration could also exist. On this basis, it was assumed that the simplest elementary particles would be either symmetric or anti-symmetric under reflection of all coordinates.

Then certain restrictions on the behavior of unstable elementary particles can be derived. The particle which is principally responsible for nuclear forces is the "π-meson," often called the "pion." In recent years heavier mesons have been discovered which decay into pions, and the selection rules derived from reflection invariance implied that a "theta-meson," which decays into two pions, could not be the same particle as a "tau-meson," which decays into three pions. But experimental evidence gradually mounted that the theta-meson and the tau-meson were similar in all other respects except their decay: a) they had the same lifetime of about 1.2×10^{-8} seconds; b) they have the same mass of 966 times the electron mass, to within the experimental accuracy of two electron masses, and both existed with positive and negative charge; c) they were produced with approximately the same relative probability compared to other particles in all nuclear interactions and seemed to behave identically in all of the strong nuclear interactions; d) both appeared to have zero intrinsic angular momentum or spin.

These similarities seemed too great to be a coincidence and strongly suggested that the tau-meson and theta-meson were actually the same particle with two alternate modes of decay. This was possible only if there was a violation of the "conservation of parity" or of the reflection character of the particles. Thus, Professors T. D. Lee, of Columbia University, New York City, and C. N. Yang of the Institute for Advanced Study, Princeton, New Jersey,[1] proposed a year ago a series of experiments which could test the conservation of parity.[2] The analysis of Lee and Yang showed that parity was conserved in the electromagnetic interactions, such as the emission of light, and in the stronger interactions, which are important in nuclear collisions. However, the weaker interactions responsible for the decay of radioactive atoms or of metastable elementary particles had not yet been adequately tested experimentally for the conservation of parity.

Following the suggestion of Lee and Yang, the first important experiment was performed at the National Bureau of Standards by Wu, Ambler, Hayward, Hoppes, and Hudson.[3] This experiment studied the radioactive decay of the isotope "cobalt sixty" (abbreviated as Co^{60}). The Co^{60} nucleus can be viewed as a small spheroidal magnet. In this very difficult experiment, temperatures as low as 1/100 of a degree above absolute zero were utilized to align the Co^{60} nuclei in a magnetic field, and the distribution of the electrons emitted in the radioactive decay of Co^{60} was then observed. If parity is conserved, the number of electrons emitted into the upper hemisphere of directions with respect to the aligning magnetic field would be the same as into the lower hemisphere. However, the experiments showed a strong preponderance for the emission of electrons into one hemisphere, thus clearly proving that the concept of parity was not conserved in this radioactive decay.

The results of this experiment were a great surprise to physicists. (The first scientific talk reporting this work was given at the Physics Colloquium at the University of Maryland January 16, 1957, causing considerable excitement among physicists on campus when this work was reported.) Many other experiments were then undertaken to detect the conservation of parity. The next experiment by Garwin, Lederman, and Weinrich at Columbia University studied the decay of the pion.[4] Since this decay is perhaps the easiest to understand, I will describe the meaning of parity in this case. The pion has no spin, so if you view it from a frame in which it is at rest, you may picture it as a motionless spherical charge. When this particle decays, it emits two other particles, a neutrino and a muon. To conserve momentum, these two particles move in opposite directions. Each of these decay particles has an intrinsic spin which can be visualized as rotation about the particle's line of motion. If we view the departing particle from behind, its spin can be either clockwise or counterclockwise. (Because of the conservation of angular momentum, if one departing particle spins in a clockwise motion, then the other particle must also be spinning in a clockwise direction.)

Since the pion was thought of as being a completely spherically symmetric object, it was previously assumed that the decaying particles should have a clockwise or counterclockwise spin with equal probabilities. However, the Columbia experiment showed that this is not the case and that, in fact, the decaying particles always (or nearly always) spin in one direction. Other experiments have since shown that this direction for the decay of a positively charged pion is clockwise.

(Continued on page 48)

[1] For their work, they were awarded the Nobel Prize in physics in October 1957.

[2] T. D. Lee and C. N. Yang, "Question of Parity Conservation in Weak Interactors," *Phys. Rev.* Vol. 104, 254 (1956).

[3] C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes, R. P. Hudson, "Experimental Test of Parity Conservation in β-Decay," *Phys. Rev.* Vol. 105, 1413(L) (1957).

[4] Richard L. Garwin, Leon M. Lederman, and Marcel Weinrich, "Observations of Failure of Conservation of Parity and Charge Conjugation in Meson Decays: Magnetic Moment of Free Muon," *Phys. Rev.* Vol. 105, 1415(L) (1957).

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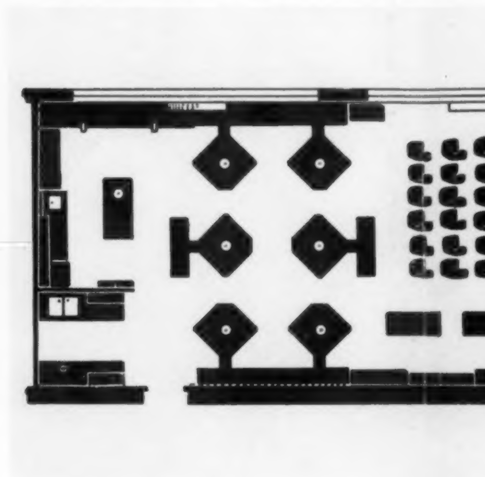

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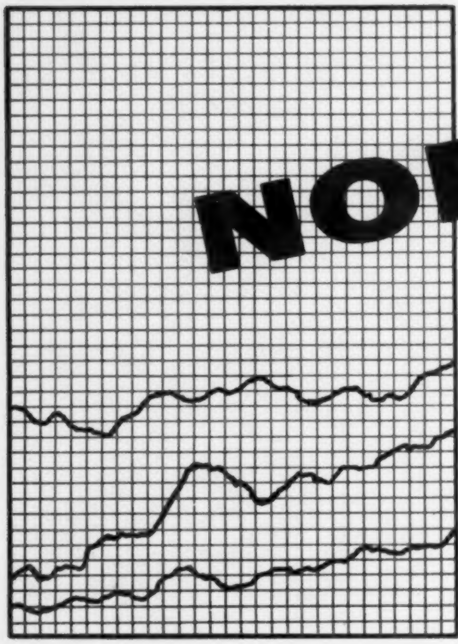


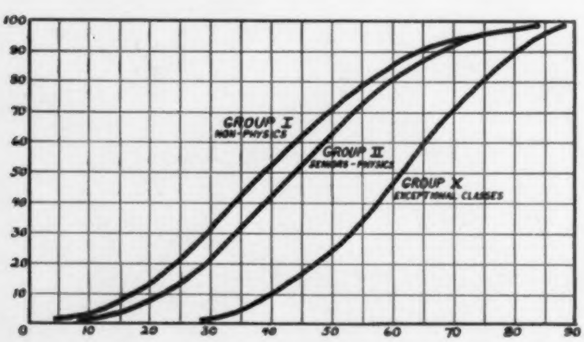
NORMS Of the High School Chemistry Test, Form N

By BROTHER H. EDWIN, F.S.C.
St. Patrick High School, Chicago, Illinois

ARNOLD M. MARTIN
Yerington, Nevada, High School

SISTER JOANNA MARIE, S.L.
Nerinx Hall Academy, Webster Groves, Missouri

WHILE attending the National Science Foundation Summer Institute at St. Louis (Missouri) University, the authors analyzed the results from the 1957 testing program of the new Form N achievement test in high school chemistry, developed cooperatively by the American Chemical Society and the National Science Teachers Association. The test, in its range of subject matter and points of emphasis, represents the combined judgment of 41 high school teachers, who constructed it as an NSTA project under the guidance of the ACS Examinations Committee. Preparation of the test followed a pattern long established by the ACS for the college level.[1] Key steps included a pilot use of the test in 14 high schools in 1956, the purpose being to assure that each question in the final selection would be of suitable difficulty and would contribute to the general discrimination among students, based on their achievement in chemistry. Elbert Weaver, Phillips Academy, Andover, Massachusetts (now on leave with the Manufacturing Chemists' Association, Washington, D. C.), served as chairman of the high school subcommittee; Walter Hauswald, Sycamore, Illinois, High School, was secretary.



Form N was released in the spring of 1957. Of the 125 schools that administered the test, 73 reported the scores of their students. These were analyzed by us and our findings appear in the accompanying table and graph. Rather significantly, a certain homogeneity is evident among the schools reporting: nearly all chemistry courses were college preparatory in nature and most teachers adhered to the traditional, descriptive approach that is common to current high school texts. Though individual classes differed markedly in their average attainment, our data revealed no clear-cut relationship between level of achievement and any of the following: size of classes, number of experiments performed, school size, geographical location, or school sponsorship, be it public, parochial, or private. Nor do the scores of juniors vary noticeably

NORMS FOR ACS-NSTA HIGH SCHOOL CHEMISTRY TEST, FORM N, 1957

	GROUP I Non-physics			GROUP II Seniors—60% physics			GROUP X Exceptional classes		
Minutes in session per week [2]	270–300, modal 275			250–330, modal 280			250–345		
Laboratory experiments	25–60, modal 40			25–45, modal 35			25–45		
Number of schools	32			10			9		
No. of students tested	2128			1026			454		
No. of students in sampling [3]	1468			744			454		
Part [4]	A	B	TOTAL	A	B	TOTAL	A	B	TOTAL
Scoring formula: R–W/4 throughout.									
Maximum possible score	45	45	90	45	45	90	45	45	90
Percentile rank [5]									
99	43	41	84	42	41	83	44	44	88
95	39	35	73	39	36	73	42	41	83
90	34	31	64	36	33	68	41	40	80
85	32	29	60	34	31	63	40	38	78
80	30	27	56	32	29	59	39	36	75
75	28	25	52	30	27	56	38	35	72
70	26	23	49	29	25	53	36	34	69
65	25	22	47	27	24	51	35	33	67
60	23	20	44	26	23	49	34	31	65
55	22	19	41	25	22	46	33	30	63
50	21	18	38	23	21	44	32	29	61
45	19	16	36	22	20	41	31	28	59
40	18	15	34	20	19	38	30	27	57
35	16	14	31	19	17	36	29	26	55
30	15	13	29	18	16	34	28	25	53
25	14	11	27	16	15	31	26	24	50
20	13	10	24	15	13	29	24	22	47
15	11	8	21	13	11	26	22	20	43
10	9	7	17	11	9	22	20	18	39
5	7	4	12	9	6	16	18	16	35
1	2	0	4	4	1	8	15	11	28

from those of seniors who had a similar background in science.

What, then, *does* cause one group of students to outperform another? Common experience points to competence and enthusiasm on the part of the teacher, as well as the students' own scholastic and social backgrounds and innate ability. The one objective factor in the data at hand that has a consistent bearing on performance is a prior course in physics. This comes as no surprise, since the two disciplines have much in common. Though the teachers' report forms did not provide for a distinction between the scores of individual physics and non-physics students, we were able to enter the majority of returns in two general categories related to this factor. Classes of juniors and of seniors, none of whom (less than 0.5 per cent) have studied physics, constitute the larger of the two groups. It is nearly representative of the typical return and is identified in the norms as "Group I, non-physics." Senior classes in which a majority of students (an average 60 per cent) have studied

[1] T. A. Ashford, Committee Report, *Jour. of Chem. Ed.*, Vol. 25, 280-2 (1948); Vol. 32, 360-3 (1955).

[2] The modal time is about five periods of 55 minutes each or seven 40-minute periods.

[3] A sampling of no more than 50 students is taken from each teacher.

[4] Norms are calculated separately for each part and for the total. Because of slight variations in the student samplings, partial scores may not "add up" to equal the total score listed for a given percentile.

[5] Percentile tells a student's rank among 100 who take the test.

physics form a somewhat higher performance group whose average score is about five points higher out of 90, equivalent to a ten-percentile difference in rank. Their designation is "Group II, seniors—60 per cent physics."

To give an idea of what can be accomplished by alert teachers working with select students, we have tallied under the heading "Group X" the norms for the 19 individual classes which ranked highest in average score. Certain of these were described by their teachers as "exceptional" or "better" classes; two were preparing for advanced college placement. Two classes consisted of sophomores; the rest were juniors or seniors, or combined. About 46 per cent of the individuals had studied physics. The nine schools represented in this group vary widely in characteristics, but there is a leaning in favor of the large suburban public school.

A brief description of the test and its potential worth is in order. Each of two parts contains material which covers the entire course and requires 45 minutes; the questions are of the five-response, multiple-choice type, with one correct response. Only about 15 of the 45 questions in each part are of the type that requires mere recognition of information, whereas 20 items relate to understanding of principles, and the ten remaining demand quantitative application of principles. A well-balanced coverage of major areas of instruction renders the test suitable for use as a final examination to measure retention of course content—a factor not wholly related to day-by-day grading methods.

We believe that teachers can look upon the results attained by their students in this test as a measure, to a limited extent, of their own classroom effectiveness. Those who use it will be prompted to adopt the point of view of the more active, forward-looking element among their colleagues. Viewed in this light, the test may well serve as a catalyst for the improvement of science teaching.

The authors express their thanks to Dr. Theodore A. Ashford, chairman of the ACS Examinations Committee, and to the officers of the high school subcommittee for the opportunity to play a part in this unique venture in testing on the secondary level. The work is being kept alive; the subcommittee, reorganized under the chairmanship of Walter Hauswald, now has a second test in the early stages of formation. Form N can be ordered through official school channels from the ACS Examinations Committee, St. Louis University, 1402 South Grand Boulevard, St. Louis 4, Missouri.

Nominees for NSTA Officers and Directors for 1958-59

Eighteen nominees have been named for seven posts in the 1958 NSTA elections. Detailed biographical data on each are given in a special brochure already mailed to all NSTA members. March 10 is the deadline for voting. The ballots should go to the elections committee chairman: Dr. William F. Goins, Jr., Department of Education, Brooklyn College, Bedford Avenue and Avenue H, Brooklyn 10, New York. Ballots should *not* be mailed to NSTA headquarters.

The list of nominees follows:

For President-Elect

Gertrude W. Cavins. Professor of Chemistry; Head, Department of Science Education; Assistant to Dean; San Jose, California, State College.

Donald G. Decker. Chairman, Division of the Sciences; Director, Laboratory School; Director, Summer Sessions; Director of Instruction; Colorado State College, Greeley.

For Secretary

Sylvia Neivert. Chairman, Science Department, Bay Ridge High School, New York City.

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NSTA Activities

Headquarters Workload

Busier than ever with its expanded services to science teachers, the NSTA headquarters staff has some administrative chores which the membership could help with. These are seemingly routine duties which are often multiplied in scope unnecessarily. For example, there are the time and personnel spent in handling delayed membership renewals. The Association membership files must be kept accurate and up to date. Failure to renew on time (December 31 was the expiration date for 1957 memberships) may not seem a critical matter to individual members. To the headquarters staff, it means that thousands of membership cards must be checked to remove the "unpaids," and then, when the renewal comes in, the whole process of reinstatement must be gone through. In addition, it means back-ordering of the journal and other services as well as a time lag for the member.

Another way in which members can help is on notification of changes of address. The Association staff has the same problems as commercial publishing firms in recording these changes; two months is generally the minimum before they take effect. Members, therefore, should notify NSTA of a proposed change of address immediately—and also be patient if the two-month interval overlaps the actual move.

Special Board Meeting

Indicative of the ferment in the field of science teaching these days, a special, called meeting of the NSTA Board of Directors was held in Indianapolis on December 26, 1957. Eleven of the 13 directors, including all members of the Executive Committee, were present to consider the agenda of 15 items. The meeting, conducted by President Glenn O. Blough, lasted from 2:25 p.m. to 10:05 p.m. Outstanding reports, policy decisions, and actions taken were as follows:

1. Financial status and outlook for 1957-58 are encouraging, notably in memberships and subscriptions which dollarwise are running well ahead of one year ago.

2. NSTA headquarters has been deluged recently with inquiries about status, issues, and recommendations in fields of science teaching. Legislators, news reporters, school administrators, and others have sought such information and advice. The Board reiterated its position on these matters as set forth in "On the Target" (*TST*, April 1957) and the editorial, "Scrutiny, Castigation, and Constructive Support . . .," in the December 1957 issue of *TST*.

3. Recognizing the Association's responsibility to contribute service through a study of proposals submitted to the organization and having to do with the improvement of science teaching, the Board took action to establish a new committee. It is described as "a continuing committee for consultation to groups and agencies offering science teaching improvement plans, its task being to recommend appropriate action to the Board of Directors (including possible endorsement) and, when considered necessary and desirable, the committee expenses being paid by the proposer."

4. In line with the action reported in item 3, the Board issued a statement commending the Berg Foundation Plan for Science Seminars for Gifted High School Students. A number of other plans for improving science teaching have been submitted to NSTA and they will be referred to the new committee.

5. Authorization was given to further planning for a summer conference for teachers to be co-sponsored by the Joint Council for Economic Education, NSTA, and the National Council for the Social Studies (see page 23).

Constitution Revised

The revised constitution recommended by the Board of Directors at its June 1957 meeting has been accepted by the membership. The total vote was 2316 of which 2295 were "yes," 18 were "no," and three ballots were returned unchecked. In view of this vote, the Board approved the revised constitution at Indianapolis and it was declared effective as of December 26, 1957.

Of particular gratification to the Board was the size of the vote—the largest on any issue ever submitted to the membership, including elections of officers. The Board was also especially pleased by the considerable number of comments made by members in casting their votes. Their remarks reflected careful reading of the revised constitution as well as understanding of the purposes of the revisions and importance of the constitution in NSTA activities.

All members are urged to file the copy of the revised constitution which was sent with the ballot. Since it was adopted as revised, there is no need for further copies to be distributed.

FSA Activities

Roster of Sponsors

By the end of the calendar year, eight more names had been added to the 1957 roster of sponsors of the Future Scientists of America Foundation. These make a total of 64 for the year, with contributions amounting to about $92,000.

A primary objective in 1958 is to obtain wider support from business-industry for FSAF activities, particularly for the general phases of the program—that is, those activities separate from specialized projects such as summer conferences for science teachers and the annual program of Science Achievement Awards for Students. FSAF was one of the pioneers in the now-widespread interest in linking business-industry more closely to science education.

Following are the 1957 sponsors not previously listed in *TST*.

The Bell Foundation, Inc.
Burroughs Foundation
Chrysler Corporation
Climax Foundation, Inc.
The General Foods Fund
Gulf Oil Corporation
Owens-Illinois
Science Research Associates

SAA: Last Call

It's close to "last call" time in the 7th annual program of Science Achievement Awards for Students. Entries must be postmarked not later than March 15. From the thousands of requests, from all parts of the country, that have come to FSAF for student entry materials, it is apparent that a great number of students are planning to take part in the 1958 program. However, FSAF officials believe there is still a rather extensive untapped potential of entries from students who do not know about the program or, unfamiliar with its diversified character, are hesitant to submit their projects.

The program is geared to grade levels within eight geographic regions. The grade groups, each with its own awards, are: (1) grades 7 and 8; (2) grades 9 and 10; and (3) grades 11 and 12. Projects may relate to any field of science or mathematics—biology, chemistry, physics, earth science, general science, arithmetic, etc. The program has one national phase; this is for projects at any of the six grade levels dealing with metals and metallurgy. Twenty national awards of $100 Savings Bonds will be made in this field.

There are no specific regulations regarding length or form of presentation. Legibility, of course, is essential. While originality of thought or line of experimentation is desirable, neither is a requirement. The important factors are awareness of scientific principles and their application, the details of how the project was carried out, an explanation of pertinent research, and a delineation of precautions taken wherever an experiment involves potential hazards.

Conducted by the Future Scientists of America Foundation, the program is sponsored by the American Society for Metals. Nearly 3000 entries were submitted in the 1957 program, of which 140 won Savings Bonds awards and 1186 received honorable mention.

In the 1958 program there will also be 140 Savings Bonds awards; there is no set limit on the number of honorable mentions. The various awards, including FSA gold pins to all winners and FSA plaques to their schools, have a cash value of $10,000.

All students with science interests, even if only on an extracurricular basis, should be encouraged to enter the SAA program. The first step is for the teacher to write to FSAF for the required number of sets of student entry materials: Future Scientists of America Foundation, 1201 Sixteenth Street, N. W., Washington 6, D. C. Keeping in mind the March 15 deadline, the teacher sponsor should make sure the student project is completed in time.

Elementary Certificates

A new incentive for encouraging science interests among elementary pupils has been developed by FSAF. It is an attractively-designed Certificate of Achievement in Science, available to elementary schools for use as a form of recognition and encouragement for pupils in the upper elementary grades.

Certificates will be sent in quantity, free of charge, in response to requests on official school stationery, signed by the school principal. FSAF suggests the certificates be distributed to not more than ten per cent of the pupils.

In deciding to provide the certificates, FSAF officials recognized that there are teachers who discourage the use of this type of external stimulation. However, FSAF advisors pointed to the effective use of such incentives by the Cub Scouts, the School Safety Patrol, and other similar groups.

The certificates are being produced with financial assistance from the American Society for Metals.

ZIM . . . from page 14

average school with the average science program. We find a willing but untrained teacher, with a minimum of help, is doing her best at a task she little understands. Visitors to classrooms during science periods have noted the large amount of time devoted to reading the textbook and to reciting facts from it. Sometimes there is informal discussion; occasionally there may be a filmstrip or a movie. The above-average teacher attempts some simple activities; germinating bean seeds, demonstrating a magnet, or keeping a record of the daily temperature. It is very rarely that anything in the elementary or junior high school classroom, or even in the high school laboratory, begins to approach the kind of science that enables a pupil to discover new facts in relationship to some question or problem. Should we not ask, without deprecating the sincere efforts that are being made, "Where is the science in science education?"

At this point, there is a temptation to also ask if all we may rightly expect in school is for children to study *about* science, rather than to participate in it. Nothing could be farther from the truth. A child can participate in science on his own level of maturity in just the same way that he participates in art, in music, in athletics, and in citizenship. The science of the child or young person is not the science of the professional, but it can be *bona fide* science, involving firsthand experiences, discovery, and communication. It makes full use of those methods which are characteristic of science, and yields the rich, intellectual stimulation which such experiences can give. Those who have watched this kind of science in action are often overwhelmed by the impact it can have on the creative imagination, and yet, at the same time, it imposes—even for the young child—an inherent discipline which is essential in intellectual maturation.

Perhaps it is worth stressing that science is not only possible within our program of science education, but its presence actually improves the program. Nor does it require a Herculean effort to introduce science into the elementary program, though the injection of this into high school chemistry, physics, and biology may take more doing. With youngsters a sound approach to science can almost come from letting your pupils engage in "doing what comes naturally." Youngsters are curious, interested, and observant. As a teacher, you can channel such activities into the kind of valid observations that make for science.

You can also keep in mind some informal criteria to help you decide on the possibilities of science

in the science program. Look into your room or watch your program with questions like these in mind:

(1) Can children in your classes ask all kinds of questions and get help from the teacher in finding out the answers?

(2) Can the children try things out for themselves (within limits of reasonable safety) or are their activities limited to pre-selected and stereotyped "experiments?"

(3) Do the children have the time and materials to get firsthand experience with many aspects of their natural environment?

(4) Does your science program provide children with an opportunity to draw their own conclusions from evidence they have gathered, and to test these conclusions logically? Or is it a matter of right or wrong answers?

(5) Do your children have access to a range of authorities, a variety of books, and to the full spectrum of community resources?

(6) Are your children graded (if they must be) according to their ability in observation, asking pertinent questions, experimenting, gathering and applying data, and drawing conclusions? Or are they graded only on the recall and repetition of facts?

If there is as little science in our program of science education as I suspect, it is not a matter for recrimination, or even for finding who is at fault. A long series of circumstances through the past 25 years are responsible. In part, the difficulties reflect larger problems in the field of education. In part, they reflect the new and rapid growth of a novel area of learning, introduced into the schools without adequate preparation or understanding. They also represent something of our failure as a nation to understand the scientist and to effectively use the methods of science, which, as applied to technology, have made us the richest country in the world.

That the situation in science education persists is also due to a number of factors, many of which can be corrected. We still labor under the fallacy that any elementary or junior high school teacher can teach science. He or she can, but only when backed up by the help of a consultant or some other professional adviser, and when given the proper equipment and adequate time to prepare. We labor under the partial fallacy that elementary science is simple, and hence can be taught with simple, homemade equipment. Yet no one expects the art teacher to mix her paints, or the music teacher to tune her own piano. Homemade apparatus often requires skill, patience, and know-how beyond that of the average classroom teacher. We also find ourselves saddled with an overcrowded curriculum, and by a heated controversy as to what it should include and why.

The problem of science instruction can only be solved as progress is made with the total school curriculum. Finally, teachers are laboring to overcome another traditional American fallacy—the idea that the school building represents the school. Communities will go deeply into debt to erect the best school building, but will immediately curtail its usefulness by failing to provide sufficient funds for essential equipment, staff, and maintenance.

If the problem were only an academic one, I would not ask, "Where is the science in the science curriculum?" The answer to this same question has been pursued during the past year by the working group of the Physical Science Study Committee, including some of the world's foremost physicists. (See the November 1957 issue of *The Science Teacher*.) These men have become so concerned with the problems of physics in the secondary schools that they have done more than ask, "Where is the physics in the physics courses?" They have supplemented their concern by obtaining support from national foundations; by developing a large staff of teachers and consultants to prepare new textbook material, new laboratory exercises, etc.

If you teachers in the elementary and secondary schools have enough personal interest in your pupils, in your school, and in this country to stand up and ask, "Where is the science in science education?" this movement, now under way, can spread until its influence is felt in all areas of science education, and in related fields as well. There are more people concerned with this question than one may suppose, and recent scientific success with satellites abroad may well sharpen our over-all concern here at home. If we all ask the question—loudly and persistently—there is a good chance of getting an answer.

TOLL . . . from page 26

Hence we can summarize this result by saying that the pion decay interaction is more complicated than we had thought previously; instead of being perfectly symmetric, there is a screw structure inherent in the particle which always (or, at least, preferentially) requires it to decay in one way. Last spring there were a series of remarkably exciting experiments verifying the non-conservation of parity in weak interactions. I will mention briefly only the detection of the polarization of electrons emitted in radioactive decay,[5, 6] the experiments on the polarization of positrons, and the experiments on the polarization of gamma rays.[7]

One remarkable feature of these discoveries is that many of the polarization experiments of moderate energy could have been easily done several years ago, but no one thought of doing them until the high energy experiments on heavy mesons produced a puzzle which led Lee and Yang to re-examine the assumptions of parity.[2] Then the experimental discovery[3] stimulated many further experiments[4-7] and further theoretical advances.[8] This work is a good example of the interconnection between experiment and theory and of the need of continual ingenuity. Many basic experiments and interpretations in nuclear physics will now have to be re-examined. For example, the number of parameters available to describe different β-decay interactions is now doubled; it may take many years to determine the relative strength of these interactions in the various nuclear decays and to explain some remaining inconsistencies. The asymmetric polarization of the particles emitted in radioactive decay also provides an important tool for investigating many properties of matter which were previously masked.

I would like to say just one word about the present ideas of the reflection symmetry of physics. Experiment shows that the positively charged pion has a "clockwise screwiness," and at present there is no indication that a mirror image particle of the *same charge* exists. This seems to imply that the universe is unreasonably asymmetric. However, it now appears likely that, for each particle with a given charge, there exists a mirror image particle of *opposite charge*. Thus, if we couple the operation of "change of charge" with the reflection operation, this new kind of symmetry is satisfied, at least according to present experimental information. It is not yet clear what is the fundamental significance of this result, but we strongly suspect that there must be some deeper reason to explain why a positive charge is properly viewed as the mirror image of a negative charge.

Detection of the Free Neutrino

Three of the familiar basic elementary particles are the photon, the electron, and the proton. The photon is the quantum of light; the electron is the lightest charged particle; and the proton is the lightest nucleus. Corresponding to the negatively charged electron, there is its partner, the positron. For the last 25 years, physicists have also known of the existence of another stable elementary particle, the neutrino. This particle is similar to the photon in that it has no rest mass or charge, but it differs from the photon in that it has only half as great a spin and interacts less strongly with matter; in fact, the neutrino can even penetrate one light year of lead! Because of its extremely weak interactions, the neutrino was for many years observed only by the effects of its creation in the decay of radioactive atoms. However, during the past year an extremely difficult experiment was completed by Reines and Cowan of the Los Alamos Scientific Laboratory who detected the absorption of neutrinos emitted from the large Atomic Energy Commission reactors at Savannah River.[9] This detection of neutrinos at a large distance from their point of creation verified the existence of these elusive particles.

Discovery of Anti-Proton and Anti-Neutron

Our discussion of parity shows how physics has been guided to a great extent by recognition of the symmetries that appear in nature. One very marked symmetry has been the charge symmetry of nature. The lightest charged particle, the electron, has a charge partner, the positron, which has the same mass and all other properties except for the change in the sign of the charge. Similarly, as each of the mesons was discovered, it was found that they existed in charge symmetric combinations, the + and — charged mu-meson, pi-meson, tau-meson, etc. This symmetry was also predicted by the relativistic quantum theory of Dirac and others. Thus

[5] H. Frauenfelder, et al., "Parity and the Polarization of Electrons from Co^{60}," *Phys. Rev.* Vol. 106, 386 (April, 1957).

[6] L. Wolfenstein and L. Page, "Polarization of β-Rays and Parity Non-Conservation," *Bull. Amer. Phys. Soc.*, Series II, Vol. 2, 190 (1957).

[7] M. Goldhaber, L. Grodzins, and A. W. Sunyar, "Evidence for Circular Polarization of Bremsstrahlung Produced by β-Rays," *Phys. Rev.* Vol. 106, 826(L) (1957).

[8] T. D. Lee and C. N. Yang, "Parity Non-Conservation and the Two Component Theory of Neutrino," *Phys. Rev.* Vol. 105, 1671 (1957).

[9] F. Reines and C. L. Cowan, Jr., "A Proposed Experiment to Detect the Free Neutrino," *Phys. Rev.* Vol. 90, 492(L) (1953). See also "The Neutrino" by the same authors published in *Nature* (1956).

physicists have known for many years that there should exist negatively charged nuclei as the counterparts of the common positively charged nuclei. However, these negatively charged nuclei were not discovered until high energy accelerators were available to produce them. As soon as the first machine in the world now capable of producing these particles was put into operation (the Bevatron at the University of California), experiments to detect these particles were begun; and in 1955, the first negatively charged nucleus, the anti-proton, was discovered by Segre and co-workers.[10,11] A year later a somewhat similar particle, the anti-neutron, was discovered in the same laboratory;[12] this particle is identical to the ordinary neutron except that the relative orientation of its magnetic moment and spin is opposite to that of the regular neutron. The anti-neutron and anti-proton form the building blocks with which, in principle, all negatively charged nuclei could be constructed. While these particles are now being regularly produced and studied,[13] it is difficult to preserve them in an ordinary laboratory because of the fact that an anti-proton will annihilate with an ordinary proton, releasing the full rest mass energy. Indeed, this "anti-matter" offers the ultimate nuclear fuel. In the ordinary fission process, which produces the energy in present nuclear reactors by the disruption of large nuclei, less than one thousandth of the total rest mass energy of the uranium nuclei is released. In fusion processes, such as those which supply the energy of the sun or are important in the thermonuclear weapons, a proportionately greater amount of the rest mass energy is utilized but still less than one per cent of the total rest mass energy. However, when matter and anti-matter annihilate, the rest mass energy is released completely,[14] so that, when we learn how to produce anti-matter in large quantities, it will form the nuclear fuel to be used in all applications where the weight of the fuel is the paramount consideration. It seems likely that eventu-

[10] E. Segre, O. Chamberlain, and others, "Observation of Anti-protons," *Phys. Rev.* Vol. 101, 947-50 (1955).

[11] E. Segre and others, "Anti-protons," *Nature* (London). Vol. 177, 11-12 (January, 1956).

[12] Bruce Cork, Glen R. Lambertson, Oreste Piccioni, and William A. Wenzel, "Anti-neutrons Produced from Anti-protons in Charge-Exchange Collisions," *Phys. Rev.* Vol. 104, 1193(L) (1956).

[13] O. Chamberlain, E. Segre, and others, "Anti-proton Interaction Cross-Sections," *Phys. Rev.* Vol. 102, 1637-40 (1956).

[14] Nearly a third of the energy would be carried off by useless neutrinos, but the useful energy release would still be proportionately much greater than in any other nuclear fuel.

all interplanetary travel will utilize as a fuel a material such as "anti-iron."

There are many problems to be solved before anti-matter can be used as a fuel. The storage of the fuel is not an insurmountable problem, for we could form a magnet of anti-matter and suspend this magnet in a vacuum by means of magnetic forces. Magnetic "tongs" could be designed to remove the fuel from the vacuum and place it when needed in a reaction chamber. But the reaction chamber would probably have to be able to operate at temperatures like those in the interior of a star, and no one has yet learned how to confine matter at such temperatures in a laboratory. The production of appreciable amounts of anti-matter will probably require many years of technological progress, but there is an intriguing alternative: There may exist other galaxies in the universe which are predominately composed of anti-matter, which could be transported by intergalactic expeditions to supply fuel needs of future generations.

Other Elementary Particles

Probably the greatest progress in physics in the past decade has been in the field of elementary particle physics. For many years, this field of physics could be studied most effectively by means of high energy cosmic rays. The study of Wilson cloud chamber pictures and photographic emulsions exposed at high altitudes revealed the existence of various metastable particles (called mesons and hyperons), which are produced in the interactions between high energy nuclei and then decay with average lifetimes varying from 2.2 microseconds to about one millionth of a billionth of a second. While these lifetimes are extremely short by ordinary standards, they are very long compared with the times of nuclear interactions; and thus these particles can escape from the region of production and be carefully studied before they decay. With the development of high energy accelerators, masses, charges, and other basic properties have been measured and the many different particles have thus been identified. Some progress has also been made in understanding these particles theoretically. They are the quanta of the various force fields of physics. Thus nuclear forces are due to the exchange of mesons between nuclei in the same way that electromagnetic forces are due to the exchange of photons between charges. It is useful theoretically to group these particles together in families, and a scheme of classification has been developed by Professor Gell-Mann of the California Institute of Technology, Professor Pais of the Institute for Advanced Study, and others.[15] This theoretical scheme accounts well for the present particles and for their interrelationships and modes of decay. However, it is still not possible to determine from fundamental physical theory such quantitative properties as the mass or lifetime of each particle.

Mu-Meson Catalysis of Fusion

A discovery was made this year which appeared at first to offer an alternative way of promoting the fusion of hydrogen nuclei without using high temperatures. Alvarez and co-workers[16] at the University of California discovered that, when a mu-meson is captured by a deuteron or heavy hydrogen nucleus, the negative charge of the mu-meson cancels the positive charge of the nucleus and another deuteron can then easily approach and be captured into a charged ion in which the two deuterons are bound together by the negatively charged meson. The two deuterons then readily coalesce to release a great amount of energy, and the mu-meson remains to produce other reactions of this kind. The reaction times are so fast that the mu-meson could produce many fusions within its lifetime of two microseconds. This suggested that the mu-meson might be used as a catalyst in a thermonuclear power plant. However, the fusion reactions produce doubly charged He^3 nuclei, which sometimes captures the mu-meson and prevents it from catalyzing further fusions. This effect, unfortunately, limits the average number of fusions that can be catalyzed and prevents practical utilization of this fusion mechanism.[17] However, this discovery is an indication of the sort of ingenious schemes that will have to be considered before thermonuclear power becomes a reality.

Nuclear Physics

Much progress has been made in recent years in the study of the structure of nuclei. Here again the mu-meson has been a useful tool, for the energy levels in which it is captured around an atomic nucleus give information about the charge distribution within the nucleus. High energy electron scattering experiments at Stanford University have also shown that the radius of the nuclear charge is somewhat smaller than had been previously believed.[18] The collective model of the nucleus as developed by

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[15] For example, see M. Gell-Mann "Isotopic Spin and New Unstable Particles," *Phys. Rev.* Vol. 92, 833(L) (1953).

[16] L. W. Alvarez, et al., "Catalysis of Nuclear Reactions by Mu-Mesons," *Phys. Rev.* Vol. 105, 1127(L) (1957).

[17] J. D. Jackson, "Catalysis of Nuclear Reactions between Hydrogen Isotopes by Mu-Mesons," *Phys. Rev.* Vol. 106, 330 (1957).

[18] R. Hofstader, "Electron Scattering and Nuclear Structure," *Reviews of Modern Physics.* Vol. 28, 214 (1956).

Bohr and Mottleson, Hill and Wheeler, and others has been strikingly confirmed by many experiments on the excitation of nuclei by long-range collisions.[19] However, much remains to be done before a quantitatively accurate nuclear theory will be achieved, but recent work of Brueckner and others on the theory of strong interactions of many bodies gives new hope of progress toward a fundamental theory of nuclear structure.

Solid State Physics

There has also been much progress in solid state physics. Cyclotron resonance techniques have been used to determine the effective electron mass within a solid,[20] while paramagnetic resonance experiments determine internal electromagnetic fields. The collective behavior of the electrons in solids have been successfully interpreted and verified by experiments on the characteristic energy losses in electron scattering.[21] Positron annihilation experiments have provided a new method for determining the momentum distribution of the electrons within a solid. One of the most interesting developments in recent years has been various methods of obtaining nonequilibrium distributions of atomic states by the so-called "optical pumping" technique and by other means. One particularly promising development is the "maser," which in principle will permit greatly increased efficiencies in detecting radiation. While these techniques are only now beginning, it is possible that they may be of revolutionary importance in astrophysics where radio astronomy methods are now being used to chart the outer edges of the universe.

This survey is most incomplete, but may give some idea of the excitement most physicists feel at the present time. In many fields of physics, we still have an incomplete picture, but there is good reason to believe that great progress will be made. For example, a 10 BEV accelerator has just recently begun operation in Russia, which should permit much more copious production of the new elementary particles than has been possible previously; and 25 BEV accelerators are now under construction at Brookhaven, New York, and Geneva, Switzerland. Physics will probably develop as fast in the next decade as in any previous period.

[19] For example, see B. R. Mottleson, "Collective Motion in the Nucleus," *Reviews of Modern Physics*. Vol. 29, 186 (1957).

[20] For example, see A. F. Kipo, "Experimental Work on Cyclotron Resonance in Semi-Conductors," *Physica*. Vol. 20, No. 11, 813-17 (1955).

[21] For example, see D. Pines, "Collective Energy Losses in Solids," *Reviews of Modern Physics*. Vol. 28, 184 (1956).

BOOK BRIEFS

Nuclear Energy in the South. Edited by Redding S. Sugg, Jr. 151p. $3.50. Louisiana State University Press, Baton Rouge. 1957.

Primarily a compilation of studies made for the Work Conference on Nuclear Energy held in Florida, August 1956. Blueprints the atomic age in the South from the present to 1975. Proposes an interstate compact for nuclear development; discusses problem of educating scientists and technologists.

Manual of Microbiological Methods. Committee on Bacteriological Technic, Society of American Bacteriologists. H. J. Conn, Editor. 315p. $5.50. McGraw-Hill Book Company, Inc., New York. 1957.

Compilation of accepted, basic procedures used for study of pure cultures of bacteria and other microbes. Practical, technical supplementary text for laboratory courses.

Science in Everyday Things. William C. Vergara. 308p. $3.95. Harper & Brothers, New York. Publication date February 5, 1958.

Question-and-answer format gives replies to hundreds of queries involving scientific principles. Of value to beginning and intermediate science students, adults with little scientific background.

Geography in the 20th Century. Edited by Griffith Taylor. 674p. $10.00. Philosophical Library, New York. 1957.

Third edition of collection of articles by 22 outstanding author-specialists, designed for mature students of geography. Informative, comprehensive, good reference book.

General Zoology. Mary J. Guthrie and John M. Anderson. 708p. $7.50. John Wiley & Sons, Inc., New York. 1957.

Comprehensive, adult level textbook, profusely illustrated with drawings and diagrams. Essentially a new book but based on material in previous four editions of the (Winterton C.) Curtis and Guthrie text.

UNESCO: Purpose, Progress, Prospects. Walter H. C. Laves and Charles A Thomson. 469p. $7.50. Indiana University Press, Bloomington. 1957.

Unofficial story of the often controversial United Nations agency, the United Nations Educational, Scientific and Cultural Organization. Traces UNESCO's development in its first ten years, evaluates its usefulness. Laves is a former UNESCO Deputy Director General, Thomson a U. S. State Department official on UNESCO programs.

How to Read Schematic Diagrams. David Mark. 160p. $3.50. John F. Rider Publisher, Inc., New York. 1957.

Lucid introduction for upper elementary, high school students interested in electronics; experimenters, hobbyists, etc. Illustrated, diagrammatic format. Soft cover binding.

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor. Space limitations prevent listings of state and local meetings.

February 20-22, 1958: Annual Meeting, the National Association for Research in Science Teaching, Chicago, Illinois

February 22, 1958: National Council for Elementary Science, Chicago, Illinois

March 2-3, 1958: National Council for Elementary Science, Seattle, Washington

March 26-29, 1958: NSTA Sixth National Convention, Denver, Colorado

April 12, 1958: National Council for Elementary Science, Atlantic City, New Jersey

April 24-25, 1958: 1958 Eastern States Health Education Conference, New York Academy of Medicine, New York City

June 27-28, 1958: NSTA Annual Summer Meeting with the National Education Association, The Ohio State University, Columbus

June 29-July 4, 1958: National Education Association Annual Meeting, Cleveland, Ohio

PUBLICATIONS TIPS

Timely, indeed, as well as helpful is the newly-published **Teacher's Federal Income Tax Guide**—a 1958 edition for 1957 returns. It's the work of Madaline Kinter Remmlein, assistant director of the National Education Association's Research Division. A handy paperback book, it is published by Channel Press, Great Neck, New York; has 150 pages including an index; price, $2.00.

A fact-filled booklet for chemistry students is the newly-revised (late 1957) edition of **Chemistry,** a Boy Scouts of America Merit Badge Series booklet. Coauthors are Robert F. Gould, managing editor of *Chemical and Engineering News,* and Philip S. Baker of Oak Ridge National Laboratory. The booklet includes nearly 40 simple demonstrations. An 82-page pamphlet, it costs 25¢; is available at Scout outlet stores.

Audio-Visual REVIEWS

CANADA GOOSE. 8 min. Color. International Film Bureau, 57 East Jackson Blvd., Chicago 4, Ill.

Recommendation: Conservation, biology, and general science areas at elementary and junior high school levels.

Content: Story of the Canada goose, its migratory habits and value, both economic and as part of the wildlife picture. Importance of the bird as a game bird is adequately covered.

Evaluation: Excellent film for teaching conservation concepts. Sequences dealing with the eagle and deer would seem to be of greater value in separate films since they have little to do with the goose. Sound and commentary tend to be a little spotty but color and photography are excellently done.

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KITTENS—BIRTH AND GROWTH. 11 min. Color. Bailey Films, Inc., 6509 De Longpre Ave., Hollywood 28, Calif.

Recommendation: Kindergarten to 4th grade.

Content: Birth, nursing, crawling, playing, and weaning of kittens. Handling and care of kittens are stressed.

Evaluation: Paced for lower elementary grades both in filming and commentary. Well photographed and organized. Should aid in building concepts and contribute to understanding.

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THE NORTHLAND SERIES. Filmstrip. 1956. Color. Walt Disney-Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: Nature study, general science, and biology areas at elementary to junior high school levels.

Content: Covers animal habitats and adaptation to arctic and sub-arctic areas. Series also includes "Marine Mammals," "Wolverines and Weasels," and "Arctic Wilderness."

Evaluation: These filmstrips contain much of value, both in beauty and factual information. Though the commentary is geared to younger students, the information given would be of use to the 10th grade. Organization and photography beautifully done. These filmstrips should aid materially in promoting interest and constructive curiosity. Review questions are most valuable.

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THE FROG. 11 min. 1957. $50 B & W, $100 Color. Encyclopaedia Britannica Films, 150 Wilmette Ave., Wilmette, Ill.

Recommendation: Senior high school biology and junior high school general science areas.

Content: Life history of the southern leopard frog. Comparison with other members of the Amphibia is made. Other species of frogs are seen and some of the calls are heard. Life cycle of the frog, from tadpole to adult, is shown in natural environment.

Evaluation: Excellent instructional, technical qualities; very fine photography.

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